

INTERNATIONAL TELECOMMUNICATION
UNION

*Telecommunications Development Bureau
(BDT)*

REGIONAL OFFICE FOR AFRICA



OVERVIEW OF CIRCUIT AND
PACKET NETWORKS

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TOPICS

- ✓ Circuit switched network
- ✓ Packet switched network
- ✓ Packet service classes/call processing
- ✓ Network considerations
- ✓ Signalling – SS7
- ✓ Performance drivers –Driving forces
- ✓ Fundamentals of INTERNET Protocol (IP)
- ✓ Convergence factors and difficulties/risks
- ✓ Conclusion



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CIRCUIT SWITCHED NETWORK

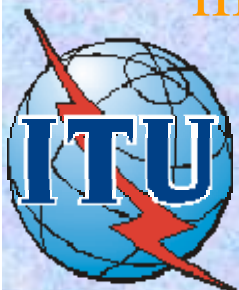
- A network that establishes a physical circuit temporarily on demand and keeps that circuit reserved to the user until it receives a disconnection signal – connection oriented.
- Provides the full circuit for the full time – full duplex.
- Assumes minimum delay and constant quality of service throughout the duration of the call.
- Traditionally all voice telephone calls have been circuit switched although the trend is changing and may continue to be like that in the future.



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CIRCUIT SWITCHED NETWORK

- All dial up modem calls are circuit switched.
- In a circuit switched network, access network provides the physical communication link between the communication endpoint and the local exchange.
- In the local exchange all users related functions are located (conversion of analogue to digital signals and vice versa, feeding of access lines, collecting of call data records, line measurements, routing, etc)



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PACKET SWITCHED NETWORK

- Packet switched network technology has been utilized for a single switched communication link to access database for multiple users simultaneously.
- Sharing network facilities with other users reduces the number of lines and modems typically needed to connect a wide area of audience with existing information resources
- Involves the segmentation of data streams into packets.



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PACKET SWITCHED NETWORK

- Packets from many users are intermixed on the same network facility.
- The packet network supports access through dial up modems, ISDN, dedicated private lines, etc.
- Over the last several decades, Packet switching technology has evolved into a data-transport platform for statistical multiplexing of low speed user traffic across large distance and today forms the basis of many advanced data communications networks.



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PACKET SWITCHED NETWORK

- Information is sent in packets through the network to some remote location.
- Information to be sent is assembled/disassembled by the PAD (Packet Assembler/Disassembler) into individual packets of data, involving a process of segmentation or subdivision of larger sets of data as specified by the native protocol of the transmitting device.
- Each packet has a unique identification and each packet carries its own destination address.



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PACKET SWITCHED NETWORK

- Each packet is independent with multiple packets in a stream of packets often traversing the network from originating to destination packet switch by different routes – Connectionless.
- Since the packets may follow different physical paths of varying lengths, they may experience varying levels of propagation delay, also known as latency.



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PACKET SWITCHED NETWORK

- Packets may encounter varying levels of delay as they are held in packet buffers awaiting the availability of a subsequent route.
- Finally they may be acted upon by varying numbers of packet switches in their journeys through the network, with each switch accomplishing the process of error detection and error correction.
- As a result, the packets may also arrive in a different order than they were presented to the network. The packet sequence number allows the destination node to reassemble the packet data in the proper sequence before presenting to the target device.



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PACKET SWITCHED NETWORK

- Originally developed to support interactive communications between asynchronous computers for time-share applications, packet switched networks are shared networks, based on the assumption of varying levels of latency and, thereby, yielding a high level of efficiency for digital data networking.



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PACKET SERVICE CLASSES/call processing

BLOCK TRANSFER

- A response to a “click” on a home page at a computer, data that contains information data and program file, such as JAVA requiring full motion video, may need to be sent all at once.
- An application Data Unit (ADU) is sent by several packets.
- Block delay is the main concern from QoS viewpoint.



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PACKET SERVICE CLASSES/call processing STREAM

- Audio and video communications require end-to-end bandwidths in the network (relate to quality).
- This type of traffic is characterized as a continuous data-transmission stream.
- In multicasting, stream data traffic may be sent simultaneously from one site to many destinations. An ADU is generated constantly or at a certain time interval.
- End-to-end bandwidth and constancy of propagation time are the main concern.



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PACKET SERVICE CLASSES/call processing TRANSACTION

- A transaction type of communication, such as that used for electronic (commerce, banking, ordering etc) generates bidirectional data transmission with small sized data packets (a few kilobits).
- Requires low data-transmission latency in the network. An ADU is sent in single packets.
- Packet latency is the main concern.



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PACKET SERVICE CLASSES/call processing

BEST EFFORT

- As with the Internet, ADU is sent without any guarantee of QoS.
- For example e-mail is non-interactive application and mail may reach the destination in a few seconds or even a few minutes



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Table 1/Y.1241 - Example of guaranteed performance attributes for IP-based services

IP -based service class	IP-based service	Guaranteed performance attribute(s) for IP-based service
Conversational	<ul style="list-style-type: none"> ● Internet Telephony ● Videoconferencing ● Video telephony ● Interactive games 	Loss, delay and delay variation
	<ul style="list-style-type: none"> ● Internet shopping ● Electronic data exchange 	Loss
	<ul style="list-style-type: none"> ● Remote login 	None
Messaging	<ul style="list-style-type: none"> ● Voice e-mail ● Internet fax ● Video e-mail ● Group e-mail 	None
Retrieval	<ul style="list-style-type: none"> ● Web browsing ● News retrieval ● File downloading 	None
	<ul style="list-style-type: none"> ● Video-on-demand 	Loss and delay variation
Distribution Service without Individual presentation control	<ul style="list-style-type: none"> ● Electronic newspaper ● Internet advertising 	None
	<ul style="list-style-type: none"> ● Live broadcasting 	Loss
Distribution Service with Individual presentation control	<ul style="list-style-type: none"> ● News-on-demand ● Video-on-demand 	Loss and delay variation

NETWORK CONSIDERATIONS

- Telecommunications networks are currently providing voice and data services worldwide with a high level of reliability and defined QoS.
- They are based on different network technologies (PSTN, ISDN, Mobile, ATM, SDH, etc) with interworking between them.
- Extension of the networks to include broadband capabilities is based on ATM technology.



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NETWORK CONSIDERATIONS

- ATM is being enhanced to provide not only for connection-oriented network services but also to meet the requirements of connectionless network capabilities and services supported by these capabilities.
- IP-based networks provide a platform that allows users connected to different network infrastructures to have a common set of applications and to exchange data with an undefined QoS.
- The IP protocol suite is evolving to include voice, data and video applications with defined QoS.



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SIGNALLING – SS7

- For signalling purposes in the circuit switched network, the Common Channel Signalling No.7 protocol is used.
- An out-of-band signalling system.
- Employs a dedicated 64kbps data circuit to carry packetized machine language messages about each call connected between and among machines of a network to achieve connection control.



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SIGNALLING – SS7

- The SS7 protocol consists of four basic sub-protocols;
 1. Message Transfer Part (MTP), which provides functions for basic routing of signalling messages between signalling points.
 2. Signalling Connection Control Part (SCCP), which provides additional routing and management functions for transfer of messages other than call set up between signalling points.



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SIGNALLING – SS7

- The SS7 protocol consists of four basic sub-protocols (cnt'd;
 3. Integrated Services Digital Network User Part (ISUP), which provides for transfer of call set up signalling information between signalling points.
 4. Transaction Capabilities Application Part (TCAP), which provides for transfer of non-circuit related information between signalling points.



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SIGNALLING – SS7

- Signalling System No.7 provides two major capabilities;
 - a) Fast call set up, via high speed circuit switched connections.
 - b) Transaction capabilities which deal with remote data base interactions.



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PERFORMANCE DRIVERS

Some of the key forces driving the evolution of networks;

- Digitalization
- Convergence of technologies in use within telecommunication, computers, consumer electronics and the move of content provision industries towards digital technology; and
- The new business opportunities, created by the unbundling of services made possible or necessary by deregulation, and other commercial/or open market pressures



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PERFORMANCE DRIVERS

Digitalization

- Traditionally, networks have been designed with specific payloads in mind, e.g. voice, video and data.
- It is expected that digital networks will become general purpose carriers of streams of bits.
- In theory this enables any type of digital network to carry any and all types of information in digital format such as voice, video or computer data.
- Moreover, the interconnection of networks will be simplified.
- There will be no more restrictions such as video being carried on special purpose cable-TV.



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FUNDAMENTALS OF IP

Internet Protocol – the part of the TCP/IP family of protocols describing software that tracks the internet address of nodes, routes outgoing messages and recognizes incoming messages. Used in gateways to connect networks at OSI network level 3 and above.

(The messenger protocol)

- TCP/IP (Transmission Control Protocol/ Internet Protocol being a networking protocol providing communication across interconnected networks, between computers with diverse hardware architectures and various operating systems.

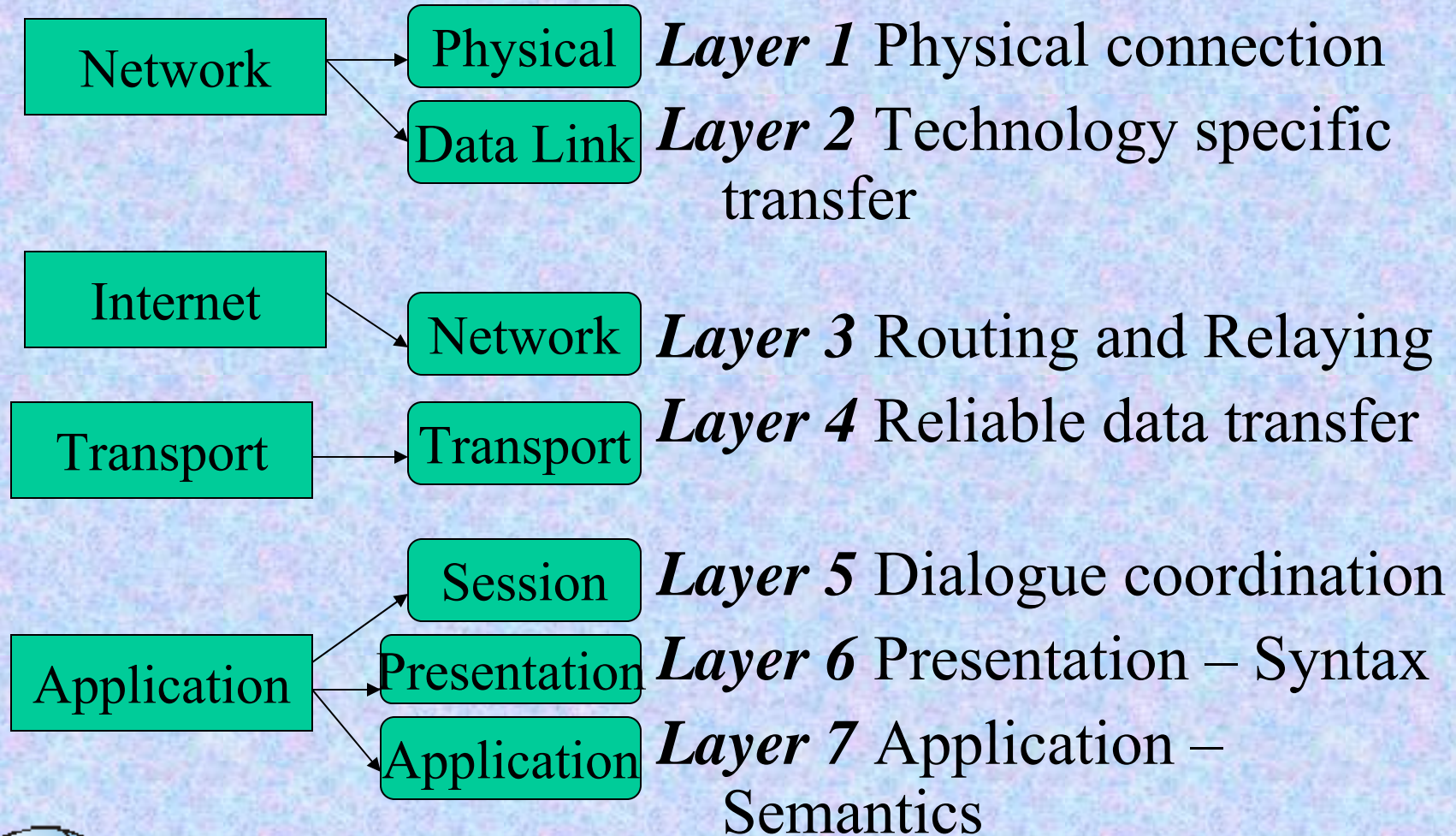


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TCP/IP NETWORKING FUNCTIONALITY

TCP/IP

OSI LAYER



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OSI REFERENCE MODEL

LAYER 1 – The physical layer deals with the physical means of sending data over lines (i.e., the electrical, mechanical and functional control of data circuits). Examples include, Rs-232, T/E-carrier, SONET/SDH etc.

LAYER 2 – The data link layer is concerned with procedures and protocols for operating the communication lines. It also has a way of detecting and correcting message errors. Examples include Frame Relay, PPP (point-to-point Protocol), and SLIP (Serial Line Internet Protocol). ATM runs layer 1 & 2 as do LANs.



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OSI REFERENCE MODEL

LAYER 3 – The network layer determines how data is transferred between computers. It also addresses routing within and between individual networks. The most visible example is the IP (internet Protocol).

LAYER 4 – The transport layer defines the rules for information exchange and manages end-to-end delivery of information within and between networks, including error recovery and flow control. TCP (Transmission Control Protocol) is an example, as is the OSI Transport Protocol (TP) which comprises five layers of its own. Layer 4 protocols ensure end-to-end integrity of the data session. The X.25 packet switching protocol operates at Layers One, Two, Three and Four.



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OSI REFERENCE MODEL

LAYER 5 – The Session Layer is concerned with dialog management. It controls the use of the basic communications facility provided by the Transport Layer. If you've ever lost your connection while Web surfing, you've likely experienced a session time-out, so you have sense of the Session Layer.

LAYER 6 – The Presentation Layer provides transparent communications services by masking the differences of varying data formats (character codes, for example) between dissimilar systems. Conversion of coding schemes (e.g. ASCII to EBCDIC to Unicode) and text compression and decompression exemplify the Presentation Layer functions.



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OSI REFERENCE MODEL

LAYER 7 – The application Layer contains functions for particular applications services, such as File Transfer, remote file access and virtual terminals. TCP/IP application protocol such as FTP (File Transfer Protocol), Simple Mail Transfer Protocol (SMTP), SNMP (Simple Network Management Protocol) and TELNET (TELEcommunication Network) take place at Layer 7.



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TCP/IP

- TCP/IP currently divides network functionality into four layers.
 1. A network interface layer that corresponds to the OSI Physical layer and data link layers. This layer manages the exchange of data between a device and a network to which it is connected and routes data between devices on the same network.
 2. An Internet Layer which corresponds to the OSI Network Layer. The Internet Protocol (IP) subset of the TCP/IP suite runs at this layer. IP provides the addressing needed to allow routers to forward packets across a multiple LAN inter network. In IEEE terms, it provides connectionless datagram service, which means it attempts to deliver every packet, but has no provision for retransmitting lost or damaged packets. IP leaves such error correction, if required, to higher level protocols such as TCP.



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TCP/IP

3. A Transport Layer which corresponds to the OSI Transport Layer. TCP subset runs at this layer. TCP provides end-to-end connectivity between data source and destination with detection of, and recovery from, lost, duplicated or corrupted packets – thus offering the error control lacking in lower IP routing. In TCP, message blocks from applications are divided into smaller segments, each with a sequence number that indicates the order of the segment within the block. The destination device examines the message segments and, when a complete sequence of segments is received, an acknowledgement (ACK) is sent to the source, containing the number of the next byte expected at the destination.



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TCP/IP

4. An Application Layer, which corresponds to the session, presentation and application layers of the OSI model. This layer manages the functions required by the user programs and includes protocols for remote log-in (Telnet), the file transfer (FTP), and electronic mail (SMTP).



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FUNDAMENTALS OF IP

- IP – The Internet Protocol is the most important of the protocols on which the Internet is based, the internet being packet switched network.
 - In the ITU-T, REC-Y.1001, IP, the Internet protocol is considered in its role as a protocol purely associated with transporting connectionless packets.



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CONVERGENCE

- Converged networks using IP from end-to-end, perceived NGN (Next Generation Networks)
- The latest concept of conversion is that all communications (the internet and the PSTN) shall run over one IP network.
- Converged network is used to describe trends toward the bundling of services by operators.
- Convergence of services and applications from IT, Telecom & Broadcasting industries



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DIGITAL CONVERGENCE

- Convergence from a network perspective
 - Seamless interoperability between systems
 - Network model based upon 3GPP IMS and IMS evolution.
 - Common OSS essential to realizing true convergence
- Convergence from an end user device/terminal perspective
 - Optimization to deliver content applications anytime, anyplace across multiple access technologies
 - Character of terminals drives network evolution



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DIGITAL CONVERGENCE

- Convergence from a service perspective
 - Voice is exclusive application of wireless terminals
 - Concepts of fixed and wireless not relevant
- Convergence also requires end-to-end security and QoS solutions.
 - Security is essential to services being provided perceived as being from trusted source.
 - QoS determined by user choice of service.



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Next Generation Network

Technical view

- A **single multi-service network** that carries voice, data and video bitstreams using IP over common transmission links and routers
- A network that offers **guaranteed QoS for different traffic types**
- A network in which **service logic is implemented on platforms that are separate from transport and access layers** of network

Business view

- A network that enables **fast service deployment in a cost-effective way**
- A network that **cuts network operations cost** by running single common multi-service network at the center
- A network that provides **strong edge in the competitive telecom market**

Business implications

- Now that most media can be presented digitally, Convergence is about fundamental changes in the way we work and even behave.
- Network / infrastructure evolution will allow introduction of richer services
- Services that can be introduced are a function of the bandwidth available.



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CONCLUSION

Impact of Change

Bandwidth

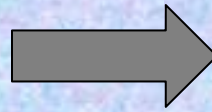
Cost

Client



Intelligent

Boundaries



Removed

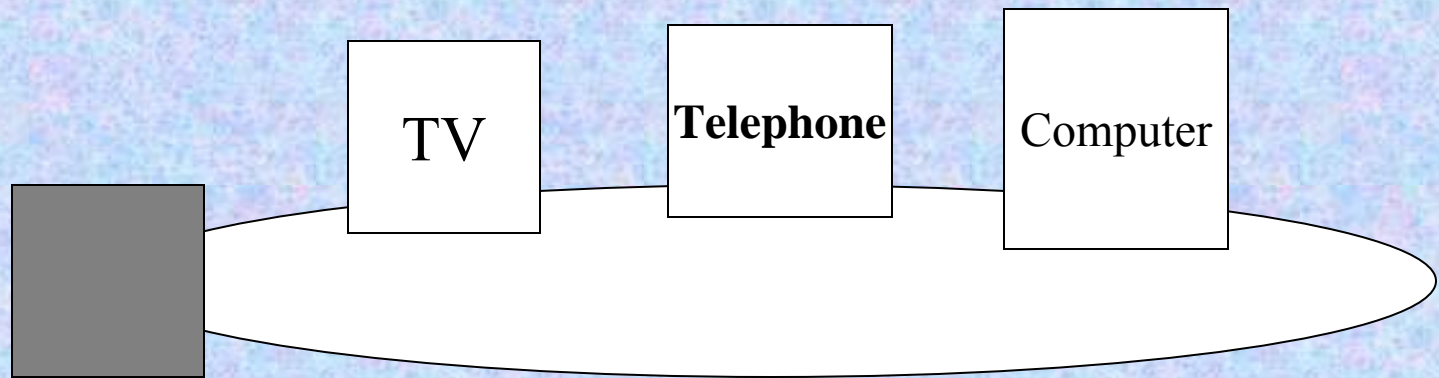
Customer Access



Self Administered

CONCLUSION

Impact of change - The end Result



Network - Voice

Connection - Internet

- Video Conferencing

- Enhanced Service Messaging

- TV

THANK YOU VERY MUCH FOR
YOUR ATTENTION

**REGIONAL OFFICE FOR
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**ANGOLA, LUANDA
OCTOBER 2005**



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